

Case Study on quantifying lean manufacturing and its effectiveness in automobile industry

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Abstract

Case studies were carried out on various automobile industries pertaining to Indian scenario, application of lean production and labour controls in the Chinese industry context, the Japanese approach to the Supply chain management, Brazilian industry and an overview of Toyota production system the case studies were carried out by adopting the various research methodologies as described below. The first step of our research was to conduct comprehensive literature review in order to collect information on fundamental lean principles. After a comprehensive literature review, a questionnaire survey combined with interviews were considered to be the most appropriate method for investigating implementation status of fundamental lean concepts in the USA, UK and Indian automotive companies. We, therefore, decided to carry out a postal survey in view of its efficiency for this kind of research with regard to the resources needed. The study was mainly restricted to automotive industry. The target population for this study was large auto manufacturing companies including both original equipment manufacturers (OEMs) and tier one (and few tier two) suppliers.

The survey questionnaire was mailed to 120 randomly selected major auto companies in August 2004. These companies represented a broad cross-section of the auto industry in USA, UK, and India. The survey covering letter promised anonymity and clearly described the objectives of the study. Further, companies were promised to provide summarized results of the study in order to enhance the number of replies. Initial response, however, was exceedingly poor. Companies who did not respond after six weeks were sent a follow-up letter along with the questionnaire.

Finally, the number of valid responses that we used for analysis was 56 amounted to a response rate of around 50 per cent. Later, it was decided to undertake an in-depth investigation in order to capture the level of understanding and extent of adaptation of lean principles and tools. In our detail investigation, we decided to interview a few managers of each major automotive company, observing company paper work, observing practices to get more clear understanding, attending review and problem-solving meetings, and having unstructured discussion with managers and engineers. A detailed report was prepared after each interaction and sent to the respective managers. The aim of the in-depth investigation process was to explore in more detail the issues that were covered in the survey.

In particular it provided the researchers with the opportunity to probe issues such as problems and impediments in adoption of lean principles. It also ensured that all questions were interpreted correctly. It allows the validity of the answers to be assessed and minimizes perceptual bias.

In this particular study, four core areas of auto manufacturing such as; production system, product development process, supply-chain management, and management style were identified to investigate the lean implementation process. Further, we captured the fundamental (or actionable) principles of lean manufacturing (or TPS), based on the literature survey and the authors' industrial working experience.

The Findings and critical observations reflect the efficacy of application of lean management in the industry scenario

Main findings of case studies on quantifying lean manufacturing and its effectiveness on auto industry

The findings of this paper presented on the subsections below were drawn from a case study conducted from

October 2006 to October 2008 in MMC Automotores do Brasil Ltd (MMCB), a Brazilian limited liability private company that assembles Mitsubishi vehicles focused on the upper classes. MMCB was founded in 1996 and is located in the municipality of Catalão (Goiás). In 2007, the company had 1,974 employees, a total area of 650,000 square meters and assembled 25,844 vehicles.

This company was chosen for study because it illustrates two trends in the Brazilian automobile industry from the mid-1990s onwards: it is a factory located far from the metropolitan region of São Paulo and its first-tier suppliers deliver subsystems, following the tendency towards the adoption of modularization.

Cotril Motors Ltd and Tokyo Comércio de Veículos Ltd, MMCB's dealers located respectively in Goiânia (Goiás) and Brasília (Distrito Federal), were also surveyed to analyze their relationship with the automaker and the degree of information exchange.

Several MMCB suppliers were located in Catalão, such as Still Revest Ltd, a firm that produced steel equipment to be used in the paint shops of the assembler; PPG Industrial do Brasil Ltd, a company specialized in producing paints for automobiles; Fórmula R Pneus, the tyre supplier; and HPE – High Performance Equipment, a firm owned by MMCB and specialized in making changes in Mitsubishi models to improve their performance in rally competitions.

Moreover, although the plant was owned by MMCB, employees from Weldmatic Automotives Ltd, RCM Engineering & Industrial Solutions Ltd and MVC Componentes Plásticos Ltd worked inside the factory.

WeldmaticAutomotives Ltd supplied equipment and offered assistance for welding operations; RCM Engineering & Industrial Solutions Ltd provided consultation services to improve the efficiency and reduce manufacturing costs; and MVC Componentes Plásticos Ltd designed and delivered plastic components for automobiles at MMCB's assembly line. During the fieldwork survey, the author could observe the activities of these suppliers and their interaction with MMCB.

Nonetheless, most of the components used by MMCB were imported from the plants of Mitsubishi Motors Co. Ltd located in Japan or Thailand. Mitsubishi Motors had two plants in Thailand (MMTh and MMTh Engine Co., Ltd) that, in 2007, produced 165,853 vehicles, of which only 26,887 were sold in the domestic market.

In Japan, Mitsubishi had three plants for vehicle production (Nagoya Plant, Mizushima Plant and Pajero Manufacturing Co., Ltd – PMC), one for engine production (Powertrain Plant Kyoto, Shiga) and one for transmission production (Powertrain Plant Kyoto), which produced a total of 875,698 and exported 614,448 vehicles (66,158 of which to Central and South America) in 2007 (Mitsubishi Motors, 2008). During the interviews conducted in MMCB, the logistics manager mentioned that the relationship between MMCB and the Japanese Mitsubishi Motors Co. Ltd was restricted to commercial transactions, i.e., no financial aid was provided and no joint problem-solving initiatives were implemented.

For the case study, interviews were also conducted in the Ministry of Development, Industry and Foreign Trade, and in the Brasília office of Anfavea (Brazilian association of automakers), with the purpose of analysing the relationship between the Brazilian government and automakers, especially regarding the negotiation process and the level of information exchange.

Emphasis on Coordination rather than Integration in Supply Chain Management

The importance of integration in supply chain management is being overlooked in the Brazilian automobile industry, as demonstrated by the case study. MMCB's key first-tier suppliers were located abroad, especially in Japan, and the factory was sited in an area remote from the industrial centers of Brazil.

Around 50% of the components came from Japan and Thailand by ship, arriving 120 days after being ordered at the port of Santos (São Paulo), approximately 770 km from Catalão. Components purchased from local firms had to be ordered 45 days in advance and they were delivered in a warehouse located in Osasco (São Paulo), 690 km from Catalão.

Suppliers delivering parts directly to the factory were a minority. As a result, the company had to keep a huge inventory to avoid the risk of stopping the assembly line. MMCB had 2 days of stock for imported components and 5 days for domestic ones. Additionally, MMCB kept an approximate 15-day stock of imported components in its Osasco's warehouse.

The company did not share information with suppliers to replenish components as they were used in the assembly line, demonstrating the lack of effort in introducing just-in-time manufacturing. The KANBAN system implemented in the automaker's plant, therefore, was not complemented by an efficient process of information exchange with suppliers and just-in-time deliveries, which resulted in huge inventory costs and low productivity.

Due to the low level of production volume and this unsatisfactory implementation of the KANBAN system, workers waiting idly inside the factory were observed during the fieldwork survey. This shows the low commitment to kaizen activities and the lack of effort to reduce non-value-added tasks.

Additionally, excessive inventories may have been concealing problems in the production process. The distance between MMCB and its suppliers hindered joint initiatives towards problem-solving and was an obstacle to just-in-time deliveries. As a consequence of this overall lack of integration in supply chain management, the company was not taking advantage of opportunities in the domestic and regional markets.

An integrative approach to supply chain management motivates continuous improvements through joint quality control efforts. Just-in-time manufacturing presupposes a low level of defective parts, which demands an intense monitoring of suppliers. In the long run, however, it decreases the need for final inspection and results in quality improvements. Since defects in components or delays may cause the stoppage of the production process, the whole supply chain network must be commitment to quality standards and punctual deliveries. In the absence of such an integrative approach in the factory, MMCB still had to conduct a thorough inspection after the assembling process and to keep large inventories.

Although it was said that workers at MMCB were trained to perform different tasks and rotated regularly to several shops in the factory, such a multi-skilled workforce was not being utilized appropriately. One of the reasons for training workers to execute several tasks is to achieve a greater level of flexibility, as they can be transferred to other stations or even perform several tasks at the same station as a way to control fluctuations of demand. The fact that idle workers could be observed in the factory reveals that the multi-skilled workforce was not being efficiently used to cope with fluctuations in the volume of production.

Fieldwork data also showed the low level of information exchange between MMCB and its dealers. There was no joint effort towards decreasing the gap between production and demand, due to the lack of a consistent process of information exchange between the dealership network, the Department of Sales and the factory. The manufacturing process started before the Department of Sales informed the sales forecast.

Dealers were not directly and formally involved in the process of sales forecasting and kept large stocks at their lots. Since dealers represent potentially a reliable source of data about customers' preferences, this low level of information exchange smothers a direct channel of communication with the final customer. While under the Lean Production System dealers are responsible for collecting data on consumers' preferences and such information becomes inputs for product development, in MMCB they only conducted surveys on customers' satisfaction. On top of that, no significant information was exchanged about new models being released or future changes in existing models, because MMCB assumed that this could affect the sales of cars already in stock at dealer's lots.

The lack of surveys to access the preferences of consumers and the impossibility to provide up-to-date information about new models had a negative impact on the capacity of dealers to provide a high quality service for customers, especially when one considers that MMCB is focused on the upper classes, which are more demanding in the fulfillment of their needs.

Furthermore, although there was an effort to adopt Visual Management within the factory, information available to blue-collar workers was insufficient, and the largest source of data was only accessible to managers, through a real-

time on line system.

This system showed all necessary information for monitoring the production process, such as: the number of FTT (First Time Through) cars; the number of defective cars; the stage that each car was at and the stage it should be at the assembly line; the total number of produced cars; and the total number of cars that were already finished and ready to be sold.

Nonetheless, for blue collar workers, real-time information was provided only through a large signboard at the end of the assembly line displaying the number of produced cars and the expected productivity for the whole day and through boards scattered in the factory showing the correct way to assemble parts. By overlooking the importance of blue-collar workers' training and by not providing the necessary real-time information for the shop floor, the company was losing latent possibilities in terms of continuous improvements, quality control and defect prevention.

In the absence of significant R&D activities in the Brazilian automobile industry, developing manufacturing capacities is paramount for creating a competitive advantage. 3.1.2 Insufficient Channels of Communication between Public and Private Sectors, Resulting in Inefficient Policies to Nurture Automakers with Low Production Volume The interviews conducted at the Ministry of Development, Industry and Foreign Trade and at Anfavea showed that this Association was crucial in advancing the interests of automakers in negotiations with the central government.

It was said that the Brazilian government did not negotiate directly with automakers and conferred the uppermost priority in negotiating directly with Anfavea. The association, on its turn, tried to represent the consensual interests of its members and did not include individual demands of automakers in negotiations with the government.

Thus, the case study showed that Anfavea played a pivotal role in advancing the demands of automakers in negotiations with the Brazilian government. Nonetheless, the sole use of this pattern of negotiation tends to distort the perception of the situation of automakers with low production volume in Brazil. This becomes evident when one considers that four automakers (Ford, General Motors, Volkswagen and Fiat) are responsible for approximately 82% of the entire vehicle production in the country (Figure 3). An overall rise in productivity of the Brazilian automobile industry conceals the existence of a large number of firms that are not achieving a considerable volume of production to reap enough benefits from economies of scale. The surveyed company MMCB, for instance, produced approximately 25,000 vehicles in 2007 and if it were to maintain the same pace of expansion since its foundation, it would take several decades to reach a satisfactory productivity level.

Table 1 reveals that the majority of automakers in Brazil reported productivity levels below 5% of the national total production, 7 of them (including MMCB) below 1%. Therefore, although the successful revitalization of the Brazilian automobile industry in the 1990s attracted several automakers to the country, it is important to create conditions to ensure that such firms will not withdraw from the country, if the economic conditions were to change.

The economic expansion of the Brazilian economy and the recognition by several scholars of the greater role the country is expected to play in the international arena in the near future (Wilson and Purushothaman, 2003; Nayyar, 2008) created an environment of optimism and propitious for attracting investment, but, at the same time, concealed several structural problems.

In fact, the analysis of the performance of the Brazilian automobile industry in the past few years reveals great reliance on the domestic market. Although vehicle exports have increased, especially in the early 2000s, it is still narrow if compared to domestic sales (see Figure 1).

This represents a threat to this industrial sector due to the domination of transnational firms. Wade (1990) acknowledges the importance for developing nations to invite transnational companies into their countries to develop knowledge intensive industrial sectors. Nonetheless, he stresses the need to persuade such firms to adopt export oriented strategies, as a way to stimulate them to use up-to-date technology and to constantly raise productivity and quality standards to offer competitive products to the international market.

In the absence of efficient export-oriented policies in the history of the Brazilian automobile industry, transnational automakers did not have to adopt up-to-date technology, but rather only basic expertise and skills to address the demand of the incipient domestic market, resulting in the stagnation of this industrial sector in the 1980s.

In fact, import restrictions were the main policy adopted by the government to protect firms producing in Brazil. However, the use of protective measures without a broader policy framework to nurture the growth of these firms and to promote the economic development of the sector allowed companies with low technological content to prosper by supplying low quality vehicles to consumers with incipient demands.

Because the Brazilian domestic market was large, incipient, and overprotected by governmental import barriers, there was no motivation for firms to enhance their quality or to adopt up-to-date technology. Although several changes have been introduced to enhance productivity and quality of the Brazilian automobile industry since the mid-1990s, at the time of the case study the market was still protected by import tax, and automakers were still primarily focused on the domestic market.

For the aforementioned reasons, it is necessary for the government to engage in more active and direct negotiating with private firms, adopting proactive policies to promote higher levels of growth in the Brazilian automobile industry. Since the Brazilian government has only restricted channels of communication with automakers, i.e. via Anfavea, the interests of automakers with low production volume in the country were not being met.

MMCB can be regarded as an example, since the company had low productivity and limited resources to expand at a faster pace. In fact, MMCB personnel acknowledged that the demand for Mitsubishi vehicles in the domestic market was greater than MMCB's production capacity. The Mercosur regional market also represents a still unexplored opportunity for the growth of the company.

Consequently, MMCB was expanding at a slow pace and was not taking advantage of latent opportunities in both domestic and regional markets. In fact, there is a low percentage of inhabitants per vehicle in the Brazilian domestic market, which represents a great opportunity for expansion.

In 2004, according to Sindipeças" (2006) database, there were 8.1 inhabitants per vehicle in Brazil. The rate is also low in other South American countries (16.8 inhabitants per vehicle in Colombia, 10.3 in Venezuela, 7 in Chile and 6 in Argentina). On top of that, in 2007, MMCB reported domestic sales of 4,845 Mitsubishi imported vehicles (Anfavea, 2008), which represents further evidence of the increasing demand in the domestic market for Mitsubishi models.

To increase the factory's output to a significant level, however, a closer relationship with its key first-tier suppliers is necessary. For this purpose, the involvement of the Brazilian government is of great relevance, in order to provide favorable conditions for the production of Mitsubishi engines as well as other subsystems domestically.

Hence, by using only one channel of communication with automakers, the government is not properly addressing the demands of automakers with low production volume and it is questionable whether they will have a sustainable position in the long run. The case study also showed that MMCB was attracted to Catalão mainly due to fiscal incentives and lower labour costs. MMCB received fiscal incentives from the local government, especially the exemption of a value-added tax on the circulation of goods called ICM Stand the reduction of the import tax.

Therefore, it could be argued that a number of automakers operating in Brazil do not have a competitive advantage in manufacturing and are merely taking advantage of a favorable environment. Under such terms, a slowdown in the Brazilian economic growth would result in the contraction of the automobile industry and a new period of stagnation.

Furthermore, this policy of granting tax exemptions to attract automakers to regions remote from Brazilian industrial centers also shows a still inefficient pattern of collaboration between public and private sectors towards the achievement of high level of industrial growth. The case study conducted in MMCB illustrates the efforts of local governments to attract investment to their municipalities in order to promote regional growth. Several other states in Brazil offered tax exemption as a way to attract automakers to their localities from the mid-1990s onwards. However, in some cases automakers were not followed by their first-tier suppliers, because incentives were rarely granted to subsidize the construction of suppliers' new plants.

On top of that, since supply chain management in Brazil follows the Western approach and is focused on short-term relations, first-tier suppliers were reluctant to invest in new facilities that would create a greater dependence on a single automaker. As a result, this policy of tax exemption increased the geographic distance between automakers and first-tier suppliers, further decreasing the level of integration in the supply chain network.

The following are some of the negative consequences of this lack of integration: high inventory costs, low productivity, incomplete implementation of the KANBAN system, and the necessity to increase final inspection of assembled vehicles. For public policies to be more effective, a partnership between the local government and the automaker should be made, to attract key first - tier suppliers to the region and promote a higher level of integration in the supply chain network. In this manner, regional development will be promoted without jeopardizing the integrity of supply chain networks.

The use of the term "Lean" in a business or the manufacturing environment describes a philosophy that incorporates a collection of tools and techniques used into the business or in an organization to optimize human resource, assets and productivity simultaneously improving the quality level of products and services to their customer (1).

There is sort of conflict for taking the credit of introducing lean manufacturing. Some say it was Henry Ford who introduced it and some other believes that it was Toyota.

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